Time granularity

*Behind everything simple is a huge tail of complicated**

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* T. Pratchett, *I Shall Wear Midnight*, 2010

Investigating the evolution of historic artefacts most often starts with the cumbersome task of putting together various pieces of information, each with its specific characteristics in terms of precision, scope and reliability. Naturally, time slots are among the main clues analysts expect to spot when filtering and cross-examining these pieces of information.

In order to proceed to any type of reasoning (teleological or causal) one has to place all the data and pieces of information. But due to the very nature of historic data sets – heterogeneity, uncertainty, missing data, uneven distribution in time *(etc.)* – time points and intervals the analyst will identify are often inconsistent in terms of granularity.

In parallel, describing an artefact's evolution often implies taking into consideration pieces of information that correspond to cyclic or fuzzy periodic events, with here also inconsistent granularities. Typically, when analysing an isolated chapel at high altitude, the analyst will need to cope with a fuzzy cyclic behaviour – the chapel is inaccessible due to snow for a certain number of weeks during the year – as well as with a well-defined cyclic behaviour – a pilgrimage is organised on the saint's day every year.

In other words, may it be because of the nature of historic data sets, or may it be because of the heterogeneity of the events we need to report, there are very few solutions analysts can count on if they need to visualise in a consistent, insight-gaining manner the time slots they have spotted.

1 - Research context

Reasoning on the historic artefacts requires a deeper understanding of the time parameter than what we understand of it in everyday life. And if in addition we want to use visualisations to inquire into what is behind our time-oriented data, we need even more extensive understanding, analysis and control over the time parameter. Theoretical approaches are crucial in understanding the time parameter, still they are not the only solution to the problem. Another approach can be observing facts: here, historic calendars.

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When investigating the evolution of historic architecture, and putting together various pieces of information (each with its specific characteristics in terms of precision, scope and reliability), time points and intervals the analyst will identify are often inconsistent in terms of granularity.

Simple from at the first glance, the problem of time granularity becomes more and more complicated when we start to study it.

Our contribution introduces graphic solutions that combine multiple aspects of the parameter time, and particularly multiple granularities. As a first step, we initially propose a visual comparison of 25 alternative calendars, covering a wide range of historic periods and cultures or civilisations.

The contribution will present the concepts and ideas behind this research, as well as their practical applications on the tests cases and accordingly it possible benefits for researchers and practitioners in historic sciences.

What does it take to analyse similarities and differences between calendars? It naturally requires a modelling effort, through which common features can be pointed out. Poincaré wrote … *it is in the relations alone that objectivity must be sought, it would be vain to seek it in beings considered as isolated from one another…* (Poincaré, 1902).

2. Modelling and visualising historic calendars

As a first step, we initially focused on a visual comparison of 25 alternative calendars covering a wide range of historic periods and cultures or civilisations (Japanese -*Taiintaiyoreki*, Tibetan, Babylonian, Burmese, Chinese, Hebrew, Pre-Islamic - *Dżahilijja*, Incas - solar, French republican, *etc.*). At first glance a calendar is made of common notions (*e.g.* day, season, year) that need to be adjusted depending on the culture (a day finishes with the sunset in the Jewish calendar, there are nine seasons in the Inuit Calendar, a year started in November in Gaulish Coligny calendar, …).

The first visualisation we propose sums up in a synthetic way fifteen key descriptors of calendars (Fig. 1) distributed inside six visual components [1]. In order to foster comparisons across the whole collection (Fig. 2), we developed a second visualisation underlining legacies in between periods and areas, presence of cycles, alternative divisions of the year, mechanisms to cope with intercalations, *etc.*. This comparison allowed us to ascertain similar mechanisms of time discretisation - day plays role of a '*chronon*' in an overwhelming majority of cases and it is aggregated into widely used, standard granules (*i.e.* week, month, season, year, century) or some less employed ones (*e.g.* days outside a year). However the exact number of days in a given granule substantially differs (*e.g.* 12 months in a common year is not a rule but only a dominant trend).

This first result has been extended to propose a more generic framework for visualising time with multiple granularities. It is applied on two different test cases: chapel of St Anne in Southern Alps and the belfry of Cracow's former town hall.

3. Conclusions

At the current stage of development we wish to restrict our conclusions to the following remarks:

- each historical calendar has its own specific granularity,
- historical calendars are subject to change over time, including in terms of granularity,
- the day/night notion could appear as the smallest common time interval (*'universal chronon'*) within reach when wanting to compare calendars – however exceptions here exist (*e.g.* in Inuit's calendar that notion is absent),
- study of cyclic and fuzzy periodic behaviour may help in better understanding data sets we handle in the context of historic sciences,
- depending on where changes over time occur, the analysis may require different visual instruments - 'tailored' to the local conditions (in particular to the succession of calendars with various - sometimes local - time discontinuities, cycles of seasons, time granulation, *etc.*).

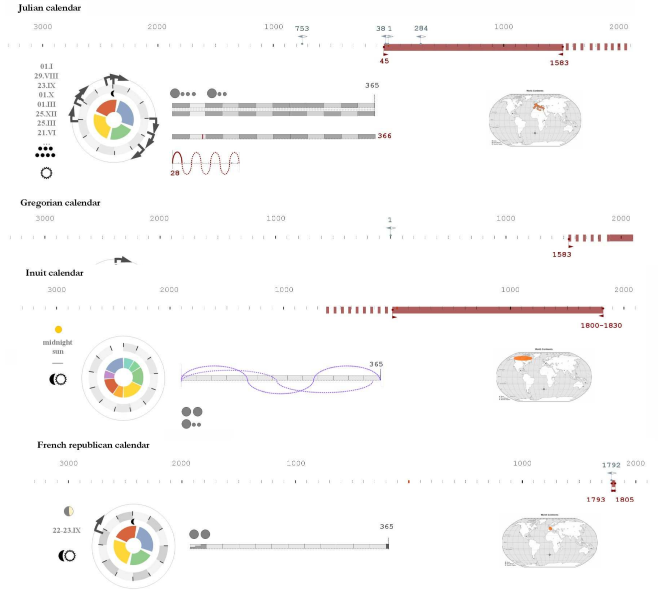

Fig. 1. Visual comparison of the Julian, Gregorian, Inuit and French republican calendars

Note 1. Granularity taken into consideration in this study is limited to a 'day' unit.

Fig. 2. Visual A visual comparison of 25 calendars